

Chapter 5 Cuttings

C5-1 Excavation

Excavation shall be carried out to the lines, levels, dimensions and slopes shown on the Drawings.

The excavated faces shall be neatly trimmed and the top edges of the cuttings neatly rounded.

Under cutting of slopes or the excavation of the toe of batters at a slope steeper than specified will not be permitted under any circumstances.

Excavation shall be carried out in such a manner as to prevent erosion or slips, working faces shall be limited to safe heights and slopes, and surfaces shall be drained to avoid ponding and erosion.

Overhanging, loose or unstable material likely to slip should be cut back removed or stabilised.

Rock cuttings and exposed rock surfaces shall be excavated so as to obtain smooth, uniformly trimmed surfaces.

Excavation at the base of cutting shall be finished at a level to suit the capping thickness, normally 150mm, and with crossfalls shown on the drawings. Tolerance on levels is between +0 and -50mm.

In addition the finished surface shall not deviate from the bottom of a 3 metre straight edge laid in any direction by more than 25mm.

C5-2 Batter Slopes

Batter slopes in rock cuttings in excess of 3m high and closer than 6m from the track centreline shall be determined on the advice of a Geotechnical Engineer.

Unless shown otherwise on the Drawings, cutting slopes should be in accordance with the following guidelines:

Material	Slope		
	Horizontal	:	Vertical
1. Sand	2	:	1
2. Wet clay, loose gravel	2	:	1
3. Sandy clay, boulders and clay compact gravelly soil, talus	1.75	:	1
4. Poor rock	1.5	:	1
5.* Sound shale dipping sharply towards railway formation, tight cemented gravel	1	:	1
6.* Ordinary rock	1	:	1
7.* Solid well bedded rock	0.25	:	1

Typical (minimum) cutting slopes

* Maximum height without bench - 7m.

* Batter slopes in rock shall be confirmed by a Geotechnical Engineer.

The slopes shown above are subject to confirmation by site specific stability analysis taking account of materials, height and excavation conditions.

Slopes shown on the Drawings represent the estimated requirements for the expected types of material and will be subject to re-determination on the basis of site inspection and investigation during excavation. Any doubtful cases must be referred to a Geotechnical Engineer.

Batters in cuttings shall be carried around curves in an even and regular manner. Finished batters shall not have a slope steeper than that specified.

C5-3

Compaction

Compaction of the top 150mm layer in the base of cuttings or of material required to fill over-excavation shall be 95 per cent relative compaction (modified) as determined by AS 1289 Test 5.2.1 or shall be solid rock.

Chapter 6 Capping

Capping material shall comply with Engineering Specification SPC 411.

The capping material shall be suitably damp during transit from the source to the worksite to prevent segregation.

The capping layer shall be constructed in layers. No single layer shall have a compacted thickness greater than 150 millimetres or less than 75 millimetres.

The material shall be spread in uniform horizontal layers so as to achieve the specified compacted thickness for the full width of the capping layer.

Spreading shall be undertaken by a method that will ensure segregation does not occur, and so as not to rut or disturb the compacted material beneath it.

Where required for compaction purposes, water shall be added as necessary to achieve optimum moisture content and mixed uniformly with the capping material by approved mechanical means.

Compaction shall achieve a minimum density of 95 per cent relative compaction (modified) as determined by AS 1289 Test 5.2.1.

Rock and rock fines shall be distributed throughout each layer so that all voids are filled. The top of the final layer shall be graded and trimmed, and material shall be added as necessary to produce an even and impermeable surface.

The following tolerances are required for the capping layer:

C6-1.1 Width

The width from the design centreline shall not be less than the dimensions for shoulder distance required by Appendix 3.

C6-1.2 Level

The finished surface of the formation shall be within 25mm of the level shown on the drawings and:

- The algebraic difference of the deviations from the correct level for any two points 20 metres apart on the centreline shall not exceed 15mm.
- The deviation from a three (3) metre straight edge laid on the surface parallel to the centreline shall not exceed 10mm.

C6-1.3 Transverse Slope

When tested with a three (3) metre straight edge laid perpendicular to the centre line the deviation from design profile shall not exceed 10mm concavity.

Chapter 7 Widening of Existing Embankments

C7-1 General

Embankments are widened:

- To dispose of spoil from other works
- To provide access to the track side
- To provide width for structures such as electrification masts
- To provide for additional tracks
- To rectify unstable or over-steep embankments.

Although embankments are often widened as a spoil disposal measure, the widened section becomes part of the embankment structure. Hence it is necessary for the work to be done in accordance with proper earthworks practice.

All work is to be in accordance with this Manual.

Sites for embankment widening are to be approved by the Civil Maintenance Engineer.

C7-2 Preparation

C7-2.1 Survey

The embankment widening shall be properly set out using batter pegs for toe of embankment and necessary survey for drainage structures.

C7-2.2 Foundation Preparation

Unsuitable materials, including vegetable matter, organic clay and silt, ash and material which is unstable when wet, are to be moved from the base of the embankment widening and the side of existing embankments.

The embankment base is to be prepared in accordance with C4-1.

C7-2.3 Drainage Structures

Existing culverts and particularly suburban drains are to be located, extended and cleared by hydroblasting or similar to ensure satisfactory flow of watercourses.

Care is to be taken to ensure that moisture is not trapped between the existing and the widened embankment, and water does not pond against the toe of the embankment.

See other standards for details of culvert construction.

C7-2.4 Drainage Blanket

A drainage blanket is to be laid at the base of the embankment in accordance with C4-2.

The procedure is:

- Excavate into the embankment toe to give a 1m scarp.
- Spread and compact layer of coarse rock 300mm thick. Scour protection shall be provided by placing large boulders on the outer edge of the drainage layer.
- Place geotextile over the drainage layer.
- The geotextile is to be covered with a layer of fill material 500mm thick compacted to Compaction B standard as detailed in C1-8.

C7-3 Embankment Construction

The embankment shall be constructed by a benching procedure as specified in C4-1, as follows:

- Excavate into the embankment to give a 1 metre scarp
- Dispose of vegetation and other unsuitable material
- The exposed material is to be identified as either:
 - Non-porous such as clay
 - free draining such as ash, sand, cobbles and boulders
 - seepage zones
- If free draining or seeping water, the bench must be connected to the lower drainage blanket, or an additional drainage layer may be constructed using coarse rock 300mm thick, as in C5-2.4
- Place compacted fill until a compacted thickness of 0.5 m is achieved
- Repeat the above steps until the top of required embankment widening is achieved.

A capping layer using spent ballast or other suitable material is to be provided at the top of the embankment, constructed in accordance with Chapter 6.

The capping layer is to be at a level below the track capping level or track formation level, with a crossfall of 1 in 30 away from the track.

C7-4 Drainage and Erosion Control

A windrow is to be provided on the embankment shoulder in sandy soils and the shoulders graded to drain to controlled drains down the embankment.

Cess drains, catch drains and mitre drains are to be provided in accordance with other standards.

Drains down the embankment are to be protected from erosion.

Appropriate erosion control is to be carried out including topsoiling, mulching and re-vegetation of embankment slope with grass and native plants.

Chapter 8 Earthworks near Structures

C8-1 Construction

Care shall be exercised in constructing earthworks within 5m of structures to avoid damage to the structures.

Non-vibratory compaction equipment shall be used within this distance of the structure and adjacent to the structure.

Free draining filter material encapsulated in geotextile fabric should be placed adjacent to weep-holes, horizontally for at least 300mm from, and vertically for 450mm above the weep-hole.

Select back fill material complying with the requirement for capping material, except that a minimum of 60% shall be retained on a 2.36mm sieve, shall be used adjacent to structures as follows:

Structure	Minimum Width & Height of Selected Fill	Compaction Method
Bridge abutment and wing walls	2m wide for full height	Hand held compaction equipment for full structure height for a distance of $\frac{2}{3}H$ (H = Overall height of structure)
Pipe Culverts	300mm width each side and above top pipes	Hand held compaction equipment for distance D from pipe to top of pipe (D = diameter of pipe)
Box culverts & culvert wing walls & retaining wall	$\frac{H}{3}$ wide for full height (H = overall height)	Hand held compaction equipment for full structure height for a distance $\frac{2}{3}H$ from wall (H = overall height)

Earthworks near Structures

C8-2 Excavation

Care should also be exercised when excavating within 5m of structures (for example near overhead wiring structures when benching into slopes for embankment widening or when excavating for track reconditioning).

No excavation should be made within this 5m distance without prior analysis of structure stability with respect to the effects of the excavation.

No excavation shall be made below the base of the footings of any structure (for example bridges, retaining walls and station platform walls) without prior analysis of structure stability with respect to the effects of the excavation.

Chapter 9 Earthworks - Geotechnical Problems

C9-1 General

Geotechnical problems require expert attention to determine the nature of the problem and the remedy required.

Maintenance staff should be aware of the warning signs that could point to potential geotechnical problems so that investigation of the problem can be undertaken by the Geotechnical Services Section.

The supporting track structure should be inspected during track patrols and detailed walking inspections.

Some warning signs to look for are detailed below.

C9-2 Embankment problems

C9-2.1 Tension Cracks

Tension cracks along the shoulder of the embankment could indicate movement of the embankment and possible shear failure.

C9-2.2 Bulge in the Slope or Toe

Bulges in the slope or at the toe could indicate heaving of the material during failure.

Any bulge in an embankment should be reported and checked.

C9-2.3 Seepage from Toe

Seepage could indicate that the embankment is saturated or the base is being weakened and a flow movement or shear failure could result.

C9-2.4 Slacks in the Track

Slacks or holes in the track could indicate embankment problems, especially if associated with tension cracks or bulges.

C9-2.5 Culverts or Pipes, Cracked or Broken

This could indicate movement within the embankment and should be reported and monitored.

C9-2.6 Local High Ballast

Ballast that is of a far greater depth than the surrounding track could indicate an old depression suggesting areas of previous problems or failure. Other warning signs could include:

- Leaning poles of structures
- Water Ponding at the toe
- Loss of Shoulder Ballast

C9-3 Problems in cuttings

The danger of rockfalls in cuttings is very high and close attention must be paid to cutting faces during inspections.

C9-3.1 Small Rock Falls

These could indicate that larger rocks may be in danger of falling.

C9-3.2 Cracks in Rock Face

Cracks should be checked as large rocks may become loose and fall. This is especially dangerous if the cracks isolate a section or block of rock especially if this isolated block is undercut.

C9-3.3 Seepage in Rock Face

Seepage could undermine or create a slippery surface causing rocks to become dislodged.

C9-3.4 Undermined Rocks

Should be investigated to determine the danger of them falling.

C9-3.5 Trees Growing from Cracks

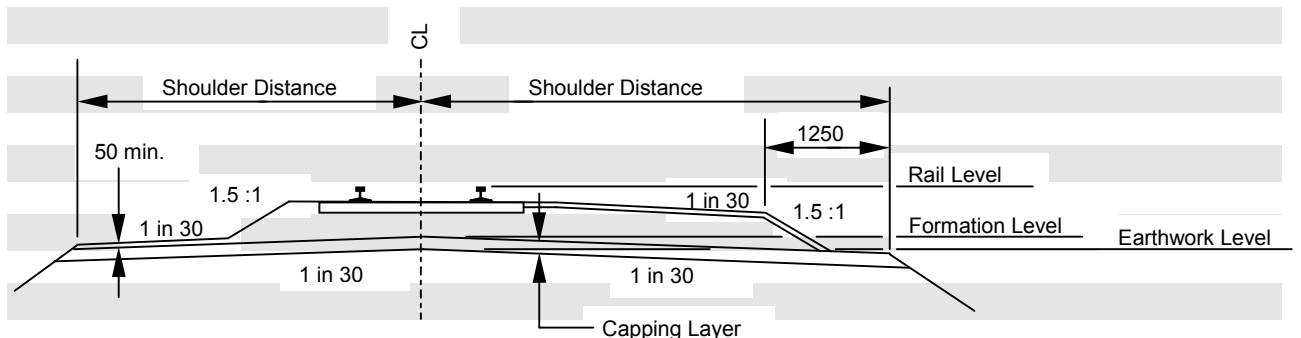
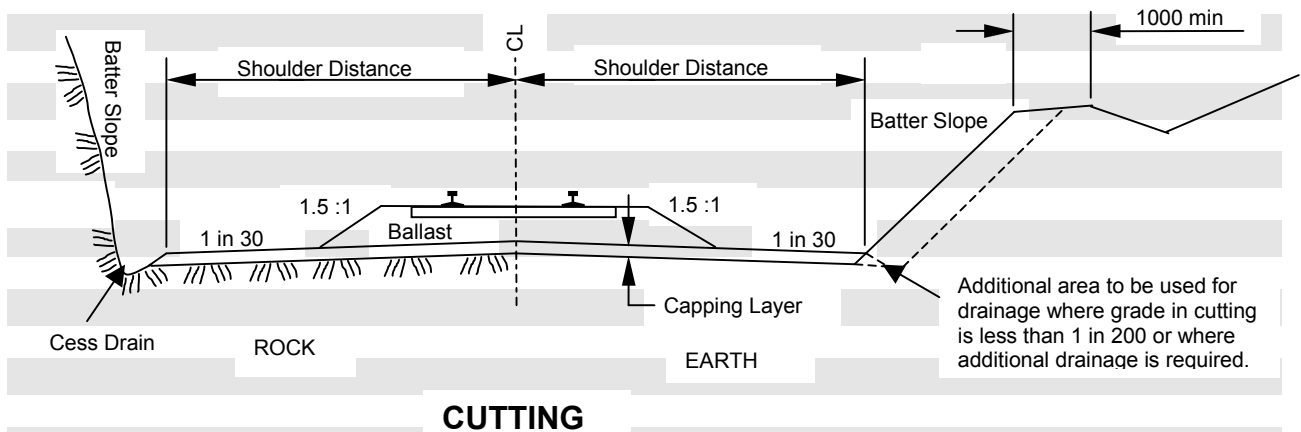
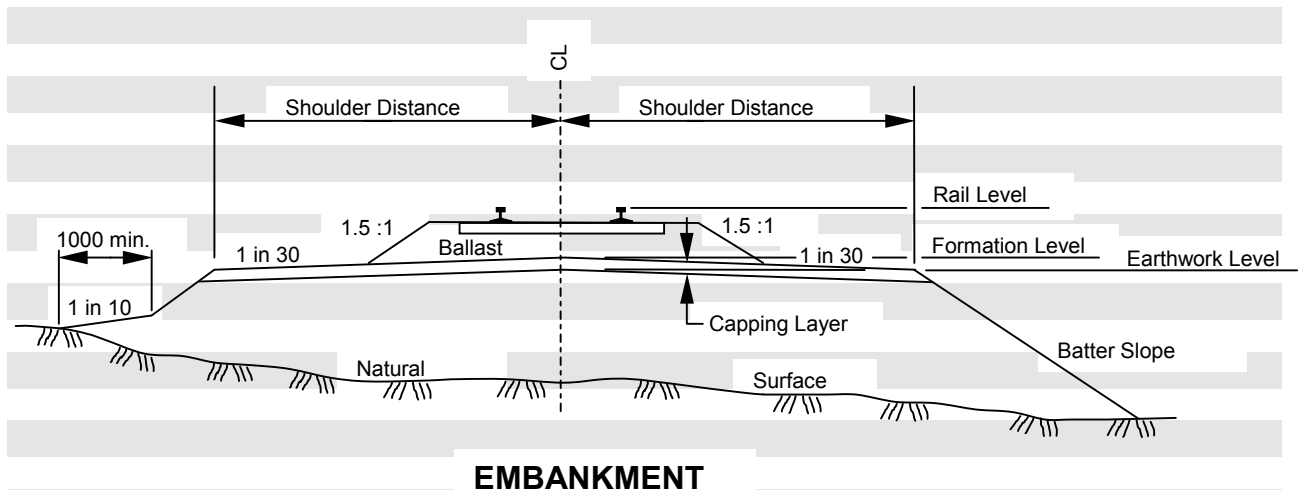
Trees growing from cracks in rock cuttings should be removed as the root action will dislodge rocks. Trees should be cut and the stumps poisoned within 5 seconds of cutting to ensure they are killed.

C9-3.6 Thick Vegetation

While thick vegetation on earth cuttings and embankments may assist in holding them stable and should not be removed, in rock cuttings it may indicate an area of soft moist earth that may undermine or cause large rocks to slip.

If any of these conditions are noticed by track maintenance staff they should be reported to their controlling officer who will arrange for the Geotechnical Services Section to investigate.

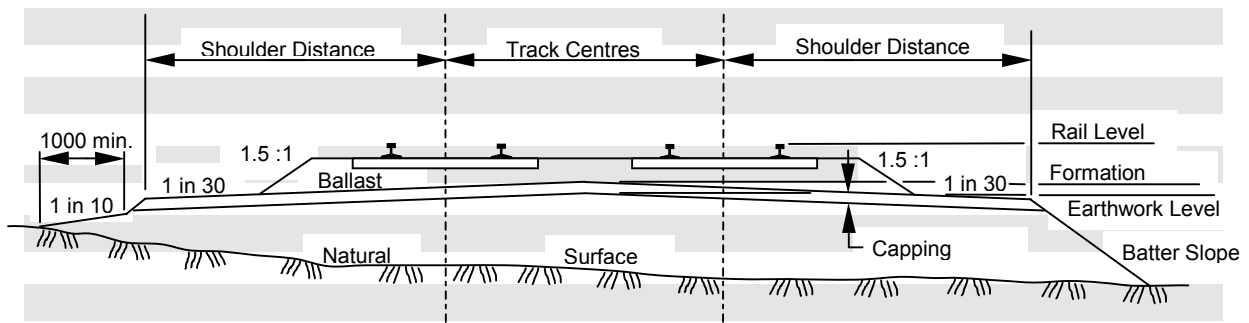
Appendix 1 – Single Track Formation (SP 521)



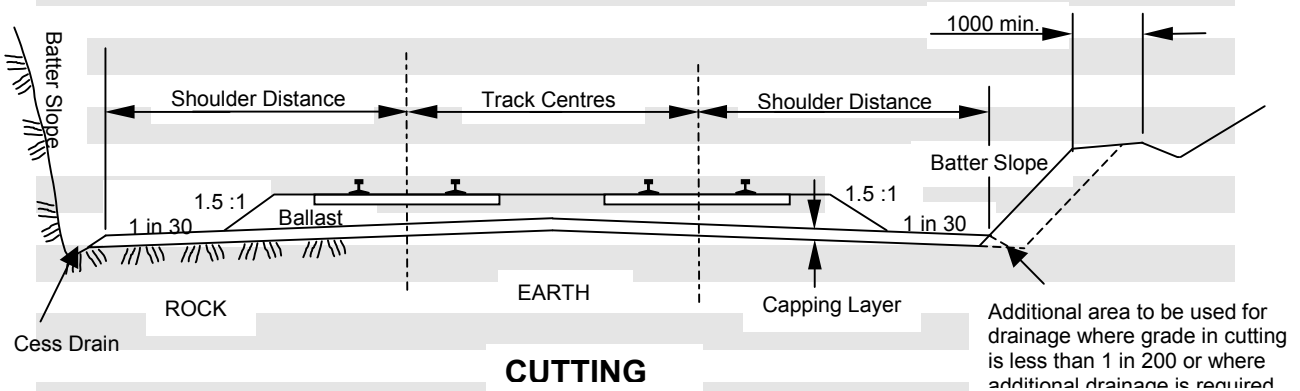
Typical section where shunters' and guards' walkways are required.

Typical section where examinations areas are specified.

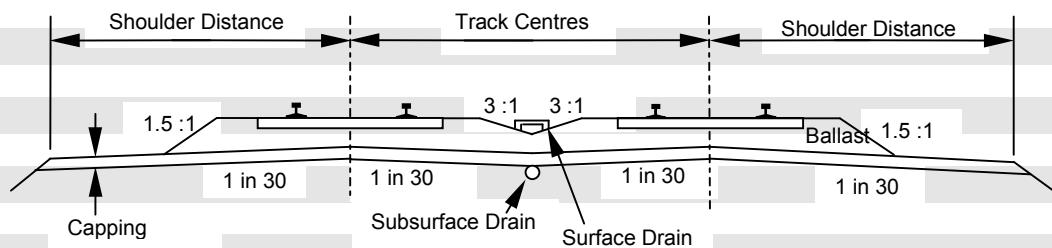
Appendix 2 – Multiple Track Formation (SP 522)



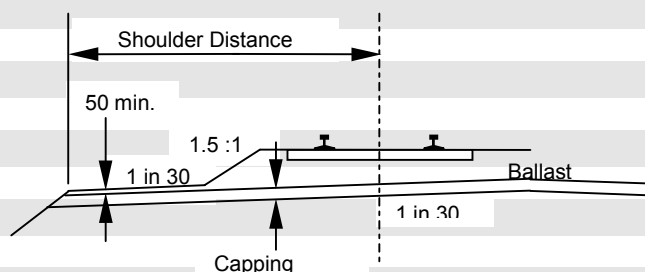
EMBANKMENT



CUTTING



CENTRE DRAIN



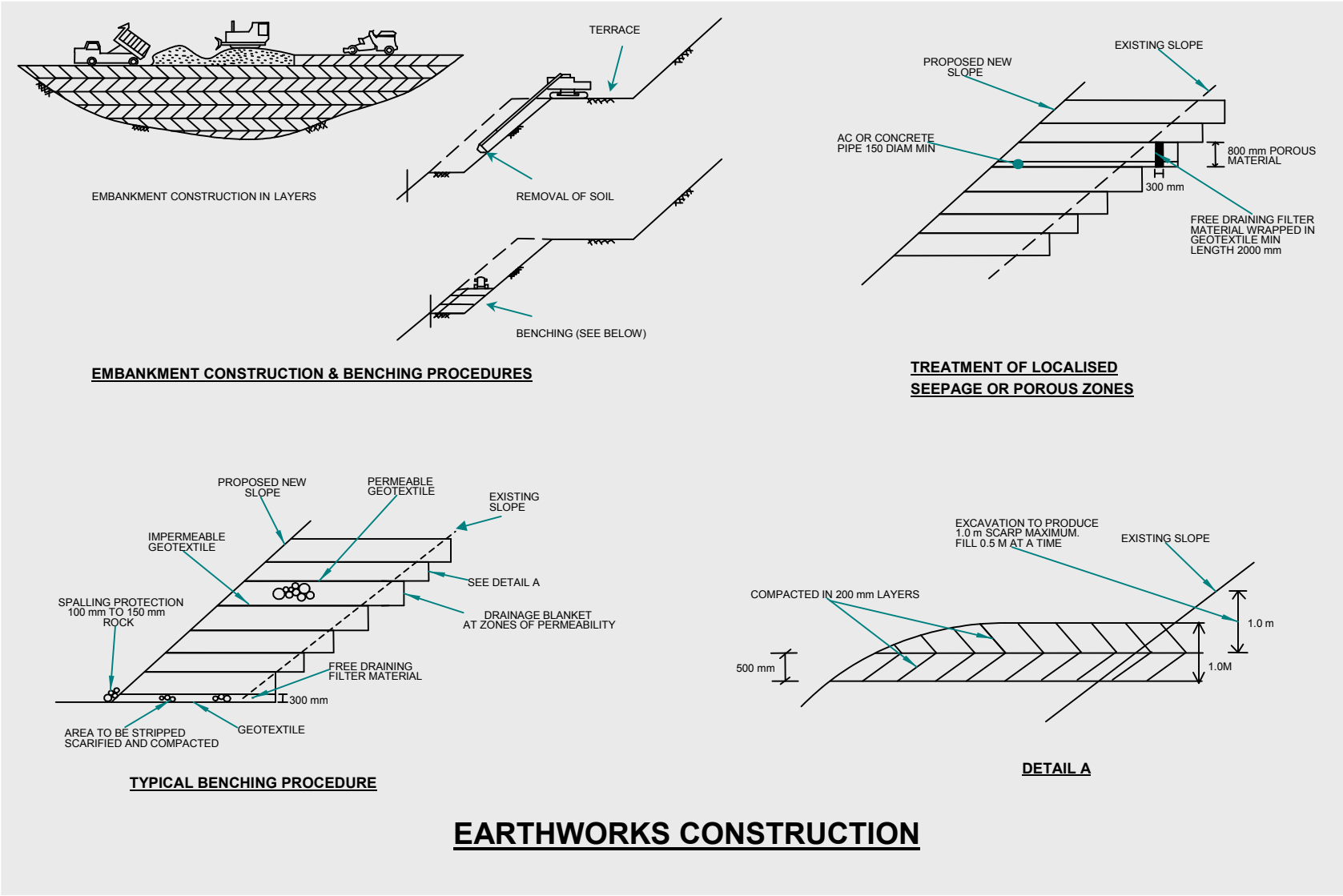
Typical section where shunters' and guards' walkways are required.

SPECIAL WIDTH REQUIREMENTS

Appendix 3 – Shoulder Distance

Shoulder width	
Plain track	mm
Main line (Electrified or non-electrified)	4250
Siding (Electrified)	4250
Siding (Non-electrified)	3000
Main line or siding with parallel access road (Electrified)	6200
Main line or siding with parallel access road (Non-electrified)	5500
Special Requirements	
Shunters and guards parallel walkways	4250
Train Examination areas	5500
Train Examination areas with parallel access road	7750
Clear width of road from back of any structure	3000

Appendix 4 – Earthworks Construction Drawing



SPC 411

SPECIFICATION

EARTHWORK MATERIALS

Version 1.0
Issue Date October, 2006

Owner Principal Engineer Geotechnical

Approved By: John Stapleton
 Group Leader Standards

Authorised By: Jee Choudhury
 Principal Engineer



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Revision Control Table

<i>Revision</i>	<i>Date of Approval</i>	<i>ECP/DCN No.</i>	<i>Summary of change</i>
1			Original Issue

1. Scope and Application

This specification details the material properties for soil used to provide the embankment material and the formation capping layer for track formation.

Embankment and capping materials used for RailCorp tracks shall comply with the requirements of this specification.

2. Version History

New specification.

This document replaces TS 3422 Standard for Formation Capping Material.

3. Applicable Standards

ESC 410	Earthworks & Formation
AS 1141	Methods for Sampling and Testing Aggregates
AS 1289	Methods of Testing Soils for Engineering Purposes
AS 1726	Geotechnical Site Investigations

4. Embankment Material

4.1. Free Draining Filter Material

The free draining filter material for drainage blankets shall be crushed rock, river gravel or slag composed of hard, strong and durable particles to satisfy the requirements of this specification.

4.1.1 Particle Size Distribution

Description	Criteria
% passing 53.0mm sieve	100
% passing 37.5mm sieve	90 - 100
% passing 26.5mm sieve	20-55
% passing 19.0mm sieve	0-5
% passing 75µm sieve	0

4.1.2 Abrasion Resistance

The Los Angeles Value (Grading A) shall be a maximum of 30%.

4.2. General Fill

General fill shall consist of material that can be compacted to not less than 95% Maximum Dry Density as determined by AS 1289 Tests 5.1.1 and 5.3.1.

Unsuitable material as defined in 4.2.1 shall not be used as general fill.

4.2.1 Unsuitable Material

Unsuitable material shall not be used. Unsuitable material includes topsoil, peat and other highly organic soils, logs, stumps, perishable material, material susceptible to spontaneous combustion, free draining materials susceptible to scouring, very fine sand, silt, organic clay and highly dispersive soils.

Dispersion shall be determined in accordance with AS 1289 Test 3.8.1. Soils with an Emerson Class number of 1 are unsuitable material.

4.2.2 Soaked CBR

The soaked CBR shall be in excess of 3%.

4.3. Structural Zone Fill Material

Structural zone fill material shall comply with the following specification requirements.

4.3.1 Particle Size Distribution

Description	Criteria
% passing 53.0mm sieve	80 - 100
% passing 2.36mm sieve	15 - 100
% passing 425µm sieve	5 - 70
% passing 75µm sieve	0 - 30

4.3.2 Atterberg Limits

Liquid Limit	Maximum 40
Plasticity Index	Maximum 20

4.3.3 Dry Density

The maximum dry density shall be a minimum of 18kN/cu.m

4.3.4 Soaked CBR

The soaked CBR shall be a minimum of 8%.

5. Capping Material

5.1. Performance Requirements

Material proposed for capping shall be a well graded natural or artificially blended gravel/soil.

It shall have sufficient fines to permit it to be compacted to high densities by static or vibratory steel-tyred rollers or by ballasted pneumatic-tyred rollers.

Finished capping material shall provide an impermeable layer.

Materials such as natural ridge gravel free from vegetable matter, ripped sandstones with low clay content and crushed and blended tough, durable rock or slag, have been found to meet the material properties of this specification.

5.2. Material Properties

Natural gravels may be combined to provide material that conforms to this specification. Crushed rock shall include such added material as necessary for the combined material to satisfy the requirements of this specification.

The material shall have properties that conform to the following requirements.

5.2.1 Particle Size Distribution

Material shall be well graded with maximum nominal size of 20mm, and with typical particle size distribution as follows:

AS Sieve Size	Percentage Passing
53mm	100
37.5mm	100
26.5mm	100
19.0mm	95-100
9.5mm	-
4.75mm	-
2.36mm	30-80
0.075mm	6-10

5.2.2 Atterberg Limits

Capping material shall comply with the following Atterberg Limits:

Liquid Limit	Maximum 30 (35 for arid areas)
Plastic Limit	Maximum 20
Plasticity Index	4 -10 (4 -15 for arid areas)
Linear Shrinkage	Maximum 3%

5.2.3 Dry Density

The maximum dry density shall be a minimum of 20kN/cu.m

5.2.4 Soaked CBR

The soaked CBR shall be a minimum of 50.

6. Validation Requirements

6.1. Sampling

Samples of materials for laboratory testing shall be taken and handled in accordance with AS 1726, and AS 1141, Section 3.

Samples of material proposed for use shall be tested and the results considered in the final selection of material.

6.2. Test Requirements – free draining filter material

The following tests shall be carried out on the free draining filter material to confirm compliance with the specified performance requirements:

Particle size distribution	AS 1289 Test 3.6.1
Soft and friable particles	AS1141. 32
Clay lumps	AS1141.30
Los Angeles Value	AS1141. 23
Particle density	AS1141.6

6.3. Test Requirements – general fill material

The following test shall be carried out on the general fill material to confirm compliance with the specified performance requirements:

Soaked CBR (Standard compaction)	AS 1289 Test 6.1.1
Dispersion – Determination of Emerson class number of a soil	AS 1289 Test 3.8.1

6.4. Test Requirements – structural zone fill material

The following tests shall be carried out on the structural zone fill material to confirm compliance with the specified performance requirements:

Particle Size Distribution	AS 1289 Test 3.6.1
Liquid Limit	AS 1289 Test 3.1.1
Plasticity Index	AS 1289 Test 3.3.1
Maximum Dry Density	AS 1289 Test 5.1.1
Soaked CBR (Standard compaction)	AS 1289 Test 6.1.1

6.5. Test Requirements – capping material

The following tests shall be carried out on the capping material to confirm compliance with the specified performance requirements: